

THE ROBBER FLIES (DIPTERA: ASILIDAE) OF A *FESTUCA* GRASSLAND IN THE OKANAGAN VALLEY, BRITISH COLUMBIA¹

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ABSTRACT

The robber flies of a small area of grassland at Penticton, B.C. were studied; information on 21 species in 17 genera was gathered during ten years of sporadic collecting. The habitat, dominated by the bunchgrass, *Festuca scabrella* and the shrub, *Chrysothamnus nauseosus*, is briefly described. Flight periods, data on prey, and zoogeographic notes are included.

INTRODUCTION

Except for a few scattered locality records in the literature, no information on the robber flies (Diptera: Asilidae) of British Columbia has been published. Because these flies are a significant component of the predatory insect fauna of the province's grasslands, I undertook a simple study of the species present in a small area adjacent to my parents' property near Penticton. I was interested in examining the temporal distribution of the species, in addition to documenting their occurrence. Such basic natural history studies are important, because robber fly assemblages in B.C. grasslands vary considerably depending on habitat details, and these habitats are rapidly disappearing in the Okanagan Valley.

THE STUDY SITE

Robber flies were collected in a small area of native grassland at 430 m elevation on the Penticton Indian Reserve at the southern boundary of the West Bench Irrigation District (49° 29.5' N x 119° 37.5' W) (Figs. 1, 2). The area is approximately 200 m x 300 m, bordered on the north by irrigated gardens and orchards, and with a dirt track running east and west near the southern edge of the rectangle.

The site is an undulating, kettle-holed terrace overlooking Penticton to the east. Penticton has a mean July temperature of 20.1° C., a mean January temperature of -2.9° C, and 235 frost-free days. The mean annual precipitation is 290 mm and the mean annual snowfall is 0.56 m (Cannings *et al.* 1987). The soil is characterized as Osoyoos Sandy Loam (Kelley and Spilsbury 1949); it is brown, fine to medium-textured soil with 3% gravel and 1.8% organics by volume. It has good moisture holding capacity, and three samples gave a mean pH of 6.7 and a salinity of 0.28 dS/m (B. Maxwell *in litt.*).

The vegetation is dominated by *Festuca scabrella* (Rough Fescue) and *Chrysothamnus nauseosus* (Rabbit-brush). The shrub layer is scattered and sparse, composed of *Chrysothamnus nauseosus* (Pall.) Britt. and a few individuals of *Artemisia tridentata* Nutt. The herb layer is dominated by *Festuca scabrella* Torr., with secondary grasses such as *Festuca octoflora* Walt., *Bromus tectorum* L., *Sporobolus cryptandrus* (Torr.) Gray, and *Poa sandbergii* Vasey. Other herbs include *Phlox longifolia* Nutt., *Lewisia rediviva* Pursh, *Fritillaria pudica* (Pursh) Spreng., *Calochortus macrocarpus* Dougl., *Zygadenus venenosus* Wats., *Geum triflorum* Pursh, *Arabis holboellii* Hornem., and *Ranunculus glaberrimus* Hook. The introduced pest *Centaurea diffusa* Lam. (Diffuse Knapweed) is abundant in disturbed areas. The bryophyte and lichen layer, however, is well developed in much of the site, and consists primarily of *Cladonia*, *Peltigera*, and *Pohlia* species.

¹ This study is a contribution to the work of the Biological Survey of Canada (Terrestrial Arthropods) and its Grasslands Subcommittee.

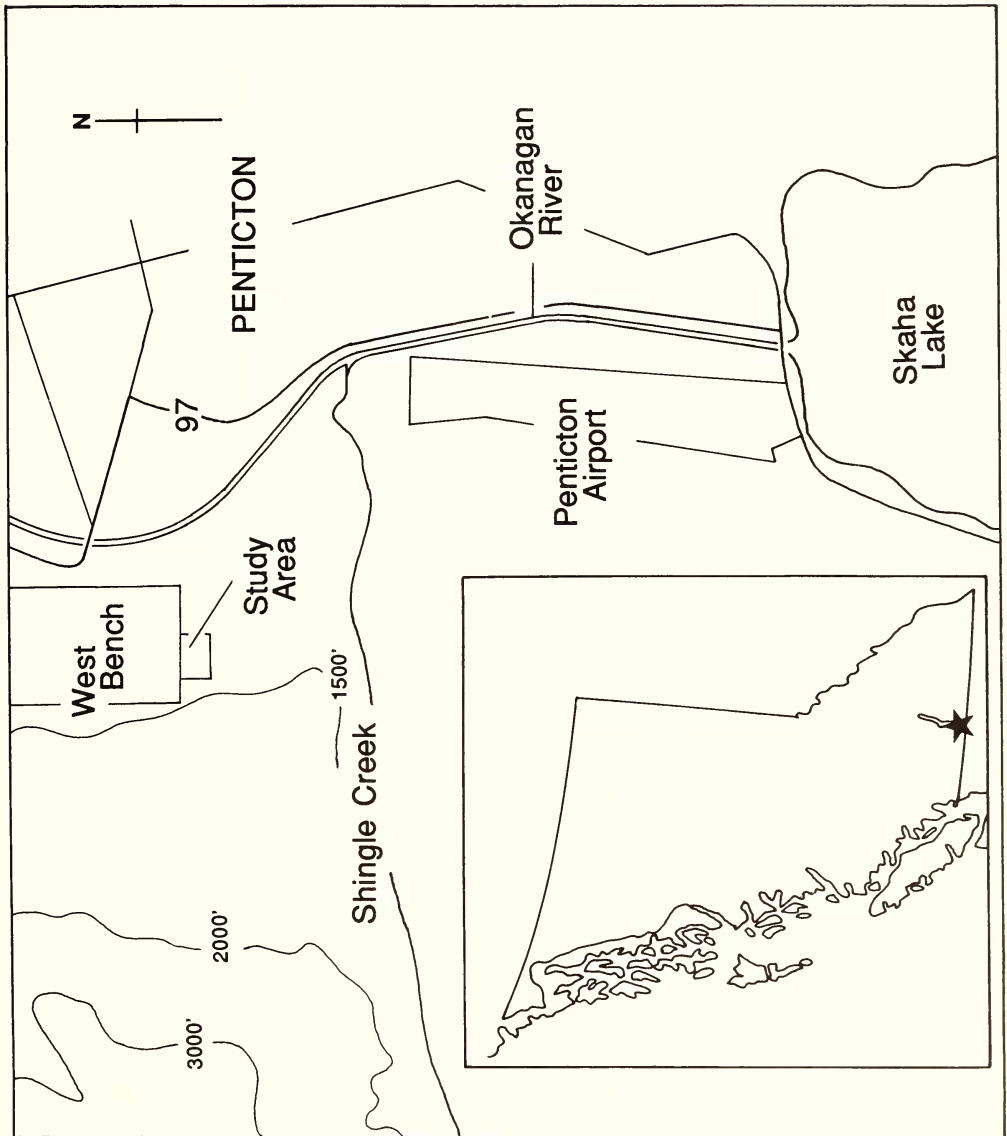


Figure 1. Location of the study area. The inset shows the position of Penticton at the south end of Okanagan Lake in southern British Columbia.



Figure 2. The study area: View south across the Rough Fescue grasslands of Pentiction Indian Reserve, West Bench, Pentiction.

METHODS

From 1980 to 1988, and in early 1989, robber flies were collected sporadically during the months that they were active (March-October) at the site. The flies were mostly caught individually in aerial nets, but beginning in 1986 a Malaise trap was also used. This was placed, with the collecting head facing south, along the fenceline at the northern edge of the site. In 1988 a second trap was located at the bottom of a hollow adjacent to a dense stand of *Rosa woodsii* Lindl.

The nomenclature used here follows Stone *et al.* (1965) for the most part; exceptions are the splitting of *Stenopogon* and *Scleropogon*, and the use of the names *Dicropaltum mesae* (Tucker) and *Neomochtherus willistoni* (Hine). These are changes included in a draft chapter (Asilidae) by Fisher and Wilcox for the updated Nearctic Diptera catalogue (E.M. Fisher, *in litt.*). In Stone *et al.* (1965) *D. mesae* and *N. willistoni* are placed in *Asilus*.

Described ranges are compiled from my own records and published statements in Stone *et al.* (1965), Adisoemarto (1967), and Adisoemarto and Wood (1975).

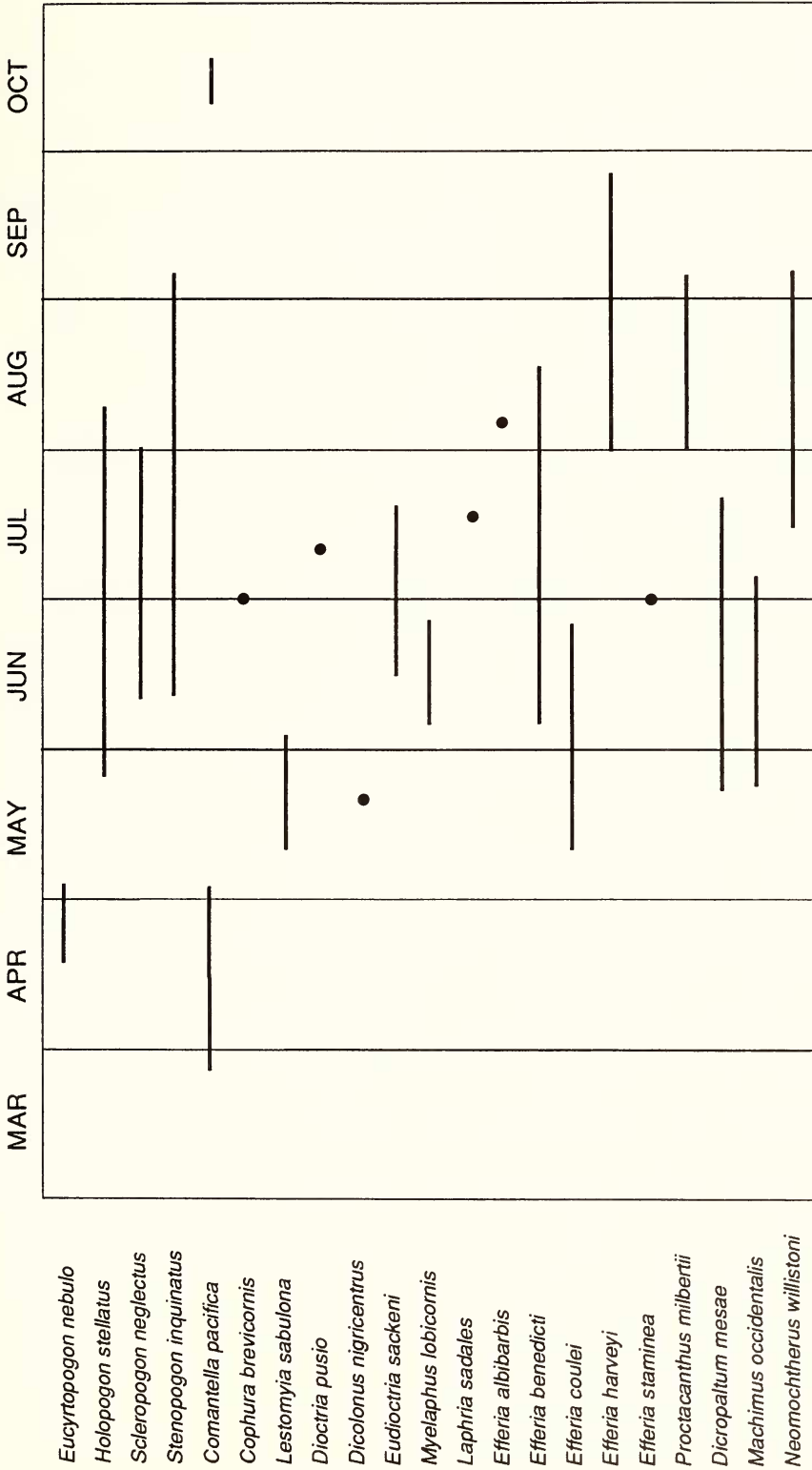


Figure 3. Phenology of West Bench robber flies. Horizontal bars represent the range of dates over which each species was collected; those represented by a single specimen are indicated by dots.

RESULTS AND DISCUSSION

Annotated List

Twenty-one species in 17 genera were collected. Collection dates and the duration of the flight periods of each species are illustrated in Fig. 3. Collection data are listed below. Collectors and repositories for specimens are as follows:

- CNC - Specimens donated to the Canadian National Collection, Agriculture Canada, Ottawa, Ontario.
 LV - Lynn Vasington (all specimens in UBC).
 MBC - M. Brent Cooke (all specimens in RBCM unless otherwise designated).
 RAC - Robert A. Cannings (all specimens in RBCM unless otherwise designated).
 RBCM - Royal British Columbia Museum, Victoria, B.C.
 RJC - Richard J. Cannings (all specimens in UBC unless otherwise designated).
 RJH - Richard J. Hebda (all specimens in RBCM).
 SGC - Sydney G. Cannings (all specimens in UBC unless otherwise designated).
 UBC - Spencer Entomological Museum, University of B.C., Vancouver, B.C.

Subfamily Dasypogoninae

Tribe Stenopogonini

Eucyrtopogon nebulo (Osten Sacken). 19.iv.1988, 1f (RAC); 20.iv.1988, 2f (RAC); 21.iv.1988, 1m (RAC); 30.iv.1989, 1m (RAC); 1.v.1989, 1f (RAC); 3.v.1989, 1m (RAC).

The genus *Eucyrtopogon* needs revision because there appear to be a number of undescribed species in western North America. The identity of the West Bench specimens is uncertain, but they resemble *E. nebulo* more than any other described species. This fly lives mainly in open, dry woods from the Yukon south to California. The few West Bench specimens were caught perched on grass as well as in the fenceline Malaise trap from 19 April to 3 May. In B.C. the species has been captured as late as 1 September (1960, Langford [CNC]).

Holopogon stellatus Martin. 25.v.1987, 1m (RAC); 14.vi.1983, 1f (RJC); 24.vi.1988, 3m2f (SGC); 25.vi.1988, 2m (SGC); 10.vii.1988, 3m3f (RAC); 11.vii.1986, 3m (RAC); 15.vii.1988, 3m 2f (RAC); 16.vii.1988, 3m5f (RAC); 19.vii.1986, 1m (RAC); 11.viii.1988, 2m1f (SGC).

A tiny black asilid of open woods and grasslands from southern B.C. south to California and Nevada, *H. stellatus* hunts mainly from the branch tips of shrubs, as do many members of the genus (Dennis and Lavigne 1975). This habitat preference is reflected in the fact that all specimens were captured in the two Malaise traps set at the shrub-grassland boundary. Specimens were recorded from 25 May to 11 August.

Scleropogon neglectus (Bromley). 10.v.1982, 1m (RAC); 12.vi.1982, 1m1f (RAC); 13.vi.1983, 3m1f (RJC); 13.vi.1987, 1m (SGC); 22.vi.1983, 1f (RJC); 30.vi.1982, 1m1f (RAC); 15.vii.1986, 1m2f (RAC); 17.vii.1988, 2m3f [1m with *Formica subpolita* Mayr (Hymenoptera:Formicidae) as prey] (RAC); 1.viii.1987, 1m (RAC,RJH).

This is a large, elongate, mainly grey species occurring in grasslands from southern B.C. and Alberta south to California and New Mexico. It tolerates a wide range of different conditions, and in southern B.C. reaches its greatest densities in the *Artemisia tridentata* stands in the hot, dry lowlands around Chopaka in the Similkameen Valley. It prefers to forage from bare ground; on the study site most were captured along the dirt track. An ant, a male *Formica subpolita*, is the only prey recorded.

Stenopogon inquinatus Loew. 10.vi.1982, 1f (RAC); 13.vi.1983, 1f (RJC); 13.vi.1987, 1f (SGC)[RBCM]; 21.vi.1983, 1f (RJC); 22.vi.1983, 1f (RJC); 30.vi.1982, 2f (RAC); 5.ix.1983, 2f (RAC).

Along with *Machimus occidentalis*, *S. inquinatus* is perhaps the most common and widespread of the large robber flies in the dry forests and grasslands of southern B.C. This heavy-bodied, reddish species ranges from northeastern B.C. south to California and east to Manitoba and New Mexico. It is much less common on the West Bench grasslands than in the adjacent open woods of *Pinus ponderosa* Dougl. (Ponderosa Pine) and *Pseudotsuga menziesii* (Mirbel) Franco (Douglas-fir). The few specimens recorded were all females; dates range from 10 June to 5 September, with all but the latter in June. One was seen attacking the asilid *Machimus occidentalis* on 9 June 1982, but was not collected.

Tribe Dasygognini

Comantella pacifica Curran. 26.iii.1988, 2m (SGC); 28.iii.1987, 1f (SGC); 28.iii.1987, 1f (SGC)[RBCM]; 2.iv.1984, 6m2f (RAC); 19.iv.1988, 4m7f [1f with *Platycheirus coerulescens* (Will.) (Diptera: Syrphidae) as prey] (RAC); 20.iv.1988, 9m (RAC); 21.iv.1988, 4m1f (RAC); 22.iv.1988, 1m1f (RAC); 28.iv.1989, 1m (RAC); 29.iv.1989, 1m (RAC); 30.iv.1989, 2m1f (RAC); 1.v.1989, 1m (RAC); 3.v.1989, 1m (RAC); 8.x.1984, 2f (SGC); 8.x.1984, 1f (SGC) [RBCM]; 13.x.1986, 2f (SGC), 1f (SGC)[RBCM]; 22.x.1983, 2m (SGC), 6m3f (RAC).

Known in Canada only from the Okanagan Valley, *C. pacifica* ranges south into the grasslands of Washington. Penticton is the type locality (4 April 1919, E.R. Buckell [CNC]). The species perches both vertically on grass and horizontally on the ground while hunting. The known flight period on the West Bench is divided into an early segment (26 March to 3 May) and a later one (8 to 22 October). The only prey recorded is the hover fly *Platycheirus coerulescens*, which is common along the dirt track in April.

Cophura brevicornis (Williston). 30.vi.1982, 1f (RAC)

This species ranges from the Chilcotin region of central B.C. south to California, Colorado, and Nebraska. In B.C., *C. brevicornis* is predominantly a denizen of open, dry woods; it is probably a wanderer to the study area. The single specimen was collected on 30 June 1982. It is rather common in the Ponderosa Pine and Douglas-fir woods on the surrounding hills in July; the latest B.C. date is 24 August (1964, Princeton [CNC]).

Leptomysia sabulona (Osten Sacken). 11.v.1983, 1m1f *in copula* (SGC); 17.v.1985, 3m (RJC); 20.v.1984, 4m (RAC); 21.v.1984, 3m2f (RAC); 22.v.1987, 1f (RAC); 29.v.1984, 2m1f (RJC), 1m1f (RJC)[RBCM]; 30.v.1984, 1m (RJC); 3.vi.1986, 1m (RJC).

L. sabulona is a small, pale robber fly ranging from the grasslands of Alberta and the southern Okanagan Valley of B.C. south to California and Wyoming. The recorded flight period is early and short, from 11 May to 3 June; a single mating was noted on 11 May.

Tribe Diottrini

Dioctria pusio Osten Sacken. 10.vii.1988, 1f (RAC).

In B.C. *Dioctria pusio* is generally found in dry woodlands; it ranges from the southern fringes of the province south to California and Colorado. The single specimen was caught on 10 June 1988 in the fenceline Malaise trap. At Robson, in the Kootenay district, where the largest series of the species in B.C. was captured, records range from 13 June to 23 August [CNC].

Dicolonus nigricentrus Adisoemarto and Wood. 18.v.1987, 1f (SGC).

A rather rare grassland species known in B.C. from the Chilcotin region south into the Okanagan and Similkameen valleys, *D. nigricentrus* ranges into Washington and northern Idaho. The single specimen is from the fenceline Malaise trap on 18 May 1987; other B.C. records range from 3 May (1987, Osoyoos, C.S. Guppy [RBCM]) to 29 June (1923, Keremeos, C.B. Garrett [CNC]).

Eudioctria sackeni (Williston). 14.vi.1987, 2f (SGC); 24.vi.1988, 1m2f (SGC); 10.vii.1988, 1m (RAC); 11.vii.1986, 2m (RAC); 14.vii.1986, 2m2f (RAC); 19.vii.1986, 2m (RAC).

This is a common species of forests and open areas in the lowlands of southern B.C. from Vancouver Island to the Rocky Mountains; it ranges south through Idaho and western Montana to California. All specimens are from Malaise traps between 14 June and 19

July. Two colour morphs are represented, designated *sackeni* and *rivalis* by Adisoemarto and Wood (1975). The character differences are most pronounced in males. The *sackeni* morph has a yellow-white face, yellow facial bristles, extensive orange markings on the legs, and in the male, the wings are orange basally, and grey apically. The *rivalis* morph has a silver face in the male, brassy in the female. The facial bristles are black, the wings are grey, and the legs are black with only the bases of the tibiae and apices of femora yellow. *Sackeni* is the more common morph, outnumbering *rivalis* 2 to 1 in the West Bench collections.

Myelaphus lobicornis (Osten Sacken). 4.vi.1983, 4m (SGC), 2m1f (RAC); 7.vii.1983, 1f (RAC); 10.vi.1982, 2m (SGC), 2m (SGC)[RBCM], 1f (SGC)[CNC], 1m2f [1 pr *in copula*] (RAC), 1m (RAC)[CNC] 3m1f (MBC), 1m (MBC)[CNC]; 12.vi.1982, 1m (RAC); 13.vi.1987, 1f (SGC); 14.vi.1983, 1m (RJC); 17.vi.1987, 1m (SGC); 22.vi.1983, 1m (RJC); 25.vi.1984, 5m (RAC).

All Canadian specimens but one (Dutch Creek, Columbia Lake, 16 July 1967 [RBCM]) are from Penticton. The species ranges south to California, Nevada and Utah. Records in the study area are from 4 to 25 June; since the periods before and after these dates were well-collected in several years, the flight period is likely restricted to June. *M. lobicornis* was collected only in open stands of rabbit-brush, where it looks and behaves much like an ichneumonid wasp. It lacks extensive bristles or body hairs, has a black head and thorax, and has unusually long antennae. The wings are blackish, the abdomen red, and the legs yellow. It flies slowly, with the abdomen and long legs dangling.

Subfamily Laphriinae

Tribe Laphriini

Laphria sadales Walker. 16.vii.1988, 1f (RAC)

Laphria species are characteristic of forests, and *L. sadales* is no exception. It shows a typical Boreal distribution across the northern forests of North America, with a southerly extension along the western mountains as far as California and Wyoming. The single specimen captured in the fenceline Malaise trap on 16 July 1988 was undoubtedly a wanderer from the Ponderosa Pine woodlands 1 km to the west.

Subfamily Asilinae

Tribe Apocleini

Efferia albibarbis (Macquart). 4.viii.1986, 1m (RAC)

This species is one of the most widespread of North American asilids, ranging across the continent and south to Guatemala. In Canada, however, it occurs only in the southern Okanagan Valley and on the beach dunes along Lake Erie in southern Ontario. The lone specimen caught (4 August 1986) was clearly out of the species' usual Okanagan habitat, which is the sandy benchlands around Oliver and Osoyoos. There is suitable habitat near the study area, however, that has yet to be investigated; it may support a small population. Records from the southern Okanagan Valley range from 9 June (1958, Osoyoos, H. & A. Howden [CNC] to 27 July (1953, Osoyoos, J.R. McGillis [CNC]).

Efferia benedicti (Bromley). 4.vi.1983, 2f (SGC); 9.vi.1982, 1m [with *Formica subpolita* Mayr (Hymenoptera: Formicidae) as prey] (RAC); 10.vi.1982, 3f (RAC); 12.vi.1982, 1m 1f (RAC); 16.vi.1983, 1m (RJC); 30.vi.1982, 1m [with *Astata bakeri* Parker (Hymenoptera: Astatidae) as prey] (RAC); 9.vii.1988, 1m (RAC); 17.vii.1988, 1m 1f (RAC); 3.viii.1986, 1f (RAC); 17.viii.1988, 1f (RAC).

Ranging from southern B.C. south to California and Arizona, *E. benedicti* is one of the most abundant robber flies of the cordilleran grasslands. In the study area it has been collected from 4 June to 17 August. Two prey species, both Hymenoptera, are recorded from these collections - the sphecoid wasp *Astata bakeri*, and a queen of the common grassland ant *Formica subpolita*. Mating was recorded on 13 May.

Efferia coulei Wilcox. 11.v.1983, 2f (SGC); 13.v.1983, 4m6f [1 pr *in copula*] (SGC); 16.v.1984, 1m (SGC); 17.v.1985, 2m (RJC); 21.v.1984, 2m (RAC); 22.v.1987, 3m3f (RAC); 26.v.1987, 1f (RAC); 28.v.1984, 1m (RJC); 3.vi.1986, 3m1f (RJC); 4.vi.1983, 3m6f (RAC); 1m1f (RAC)[CNC], 1m1f [1f with *Serica* sp. (Coleoptera: Scarabaeidae) as prey] (SGC); 5.vi.1983, 1m (SGC); 9.vi.1982, 1m2f [1f with *Salda buenoi* (McD.) (Hemiptera: Saldidae) as prey] (RAC); 10.vi.1982, 1m6f (RAC), 3f (RAC)[CNC]; 12.vi.1982, 2m3f (RAC); 13.vi.1983, 1m (RJC); 13.vi.1987, 1f (SGC); 24.vi.1984, 5f (RAC); 25.vi.1984, 2m (RAC), 2f (MBC).

E. coulei is one of the more common species of the northern mesic intermontane grasslands, ranging from the Chilcotin region of central B.C. south to central Washington. It is strictly a spring species; records on the West Bench are from 11 May to 25 June. Recorded prey species are the shore bug *Salda buenoi* and a species of the scarab beetle genus *Serica*.

Efferia harveyi (Hine). 1.viii.1987, 2m3f (RAC, RJH); 13.viii.1986, 3m3f (SGC), 2m (SGC)[RBCM]; 22.viii.1987, 6m1f (RAC); 23.viii.1987, 3m2f (RAC); 24.viii.1983, 4m2f (RAC), 1f (RAC)[UBC]; 30.viii.1983, 9m4f [1f with *Lasius pallitarsus* (Provancher) (Hymenoptera: Formicidae) as prey] (RAC), 3m (RAC)[CNC]; 31.viii.1983, 4m1f (RAC), 1m (RAC)[UBC]; 1.ix.1983, 2m4f (RAC); 2.ix.1983, 4m1f (RAC); 3.ix.1983, 2m4f (RAC), 2m2f (RAC)[UBC]; 5.ix.1983, 12m2f [1m with *Villa* sp. (Diptera: Bombyliidae) as prey, 1m with *Platymyia confusionis* (Sellers) (Diptera: Tachinidae) as prey] (RAC); 2m (RAC)[CNC], 2m (RAC)[UBC]; 6.ix.1983, 3f (RAC)[CNC]; 6.ix.1980, 1f (SGC); 26.ix.1987, 1f (RAC).

A common late summer and autumn species, *E. harveyi* ranges from the Chilcotin grasslands south through the Nicola and Okanagan valleys to California. It is at home in a variety of habitats - lowland sandy habitats dominated by *Purshia tridentata* and *Aristida longiseta*, *Agropyron spicatum* grasslands with *Artemisia tridentata*, and mesic *Festuca* grasslands.

Efferia staminea (Williston). 30.vi.1982, 1m (RAC)

This species is more or less restricted to the cooler, more mesic grassland sites in southern B.C. and is nowhere common. It ranges south to Colorado, and also occurs in southern Alberta, but is rare there. A single specimen was captured on the West Bench on 30 June 1982. Records from other parts of the valley range from 12 June (1919, Vaseux Lake, E.R. Buckell [CNC]) to 4 August (1915, Okanagan [RBCM]). Lavigne and Holland (1969) state that although the species is euryphagic, it has a preference for dipterous prey.

Proctacanthus milbertii Macquart. 1.viii.1987, 1m1f (RAC, RJH); 3.viii.1986, 2m1f (RAC); 4.viii.1986, 1f [with *Paratiphia nevadensis* Cam. or *claripennis* Cam. (Hymenoptera: Tiphidae) as prey] (RAC); 10.viii.1982, 2m (SGC); 13.viii.1986, 2m [1m with *Vespula arenaria* (Fab.) (Hymenoptera: Vespidae) as prey] (SGC); 17.viii.1988, 1m (RAC); 18.viii.1986, 1m (SGC); 22.viii.1987, 2m (RAC); 24.viii.1983, 1m (RAC); 30.viii.1983, 1m, 2f (RAC); 31.viii.1983, 1m [with *Melissodes* sp. (Hymenoptera: Anthophoridae) as prey] (RAC); 1.ix.1983, 1m2f (RAC); 2.ix.1983, 1m (RAC); 3.ix.1983, 1m1f (RAC); 5.ix.1983, 2m1f (RAC).

A very large, grey asilid with a wide geographical range, *P. milbertii* occurs from coast to coast in the U.S.; in Canada it is restricted to the southern limits of B.C., Ontario, and Quebec. In B.C. it is strictly a grassland species. In the study area it flies mainly in August (1 August - 5 September). Identified prey here are a yellow jacket wasp (*Vespula arenaria*), an anthophorid bee, (*Melissodes* sp.), and a tiphid wasp, (either *Paratiphia nevadensis* or *P. claripennis*).

Tribe Asilini

Dicropaltum mesae (Tucker). 21.v.1987, 1f (RAC); 22.v.1987, 1m (RAC); 26.v.1987, 2f (RAC); 3.vi.1986, 1f (RJC); 4.vi.1983, 1f (RAC); 9.vi.1982, 1m1f [*in copula*] (RAC); 10.vi.1982, 1m2f (RAC); 12.vi.1982, 1m2f (RAC); 13.vi.1987, 1f (SGC); 14.vi.1987, 1m1f (SGC); 26.vi.1981, 1f (SGC); 1.vii.1980, 1m (SGC); 11.vii.1986, 1m1f (RAC); 15.vii.1986, 2m2f (RAC); 16.vii.1988, 1m (RAC); 17.vii.1988, 1f (RAC); 19.vii.1986, 1f (RAC).

A common little golden species inhabiting B.C. grasslands from the Chilcotin region southward to the Okanagan Valley, *D. mesae* also ranges east into Alberta and south to Utah and Kansas. The recorded flight dates in the study area are from 21 May to 19 July, which is probably a good estimate of the extremes of the flight period in the study area. Mating was recorded on 9 June.

Machimus occidentalis (Hine). 22.v.1987, 1m (RAC); 4.vi.1983, 7m3f (RAC), 2f (SGC); 6.vi.1981, 1m (SGC); 9.vi.1982, 1m (RAC); 10.vi.1982, 4m2f (RAC); 12.vi.1982, 1f (RAC); 14.vi.1987, 1m (SGC); 16.vi.1983, 2m (RJC); 25.vi.1984, 3m1f (RAC); 25.vi.1988, 1f (SGC); 30.vi.1982, 1m (RAC); 3.vii.1981, 1f (SGC).

This is one of the most common robber flies of open, dry forest and associated grassland in the western cordillera. In B.C. it is common throughout the south from the Rocky Mountains to southern Vancouver Island at low and middle elevations. It ranges south to California and Nevada. It is a spring and early summer species; the majority of West Bench records are from June (22 May - 3 July).

Neomochtherus willistoni (Hine). 16.vii.1988, 1m (RAC); 17.vii.1988, 1m (RAC); 18.vii.1986, 3m (RAC); 19.vii.1986, 1m1f (RAC); 1.viii.1987, 2m1f (RAC, RJH); 2.viii.1987, 2m1f (SGC); 3.viii.1987, 3m (SGC); 16.viii.1988, 1f (RAC); 17.viii.1988, 1m (SGC); 22.viii.1987, 4m2f (RAC); 23.viii.1987, 1f (RAC), 1f (SGC); 24.viii.1987, 1m1f (RAC); 27.viii.1980, 1m (RJC); 31.viii.1983, 1m1f (RAC); 3.ix.1983, 1f (RAC); 6.ix.1982, 1f (LV).

Similar in general appearance and behaviour to *Machimus occidentalis*, *N. willistoni* has an almost identical distribution in B.C. However, it occurs only as far south as Washington. Unlike *M. occidentalis*, it is a late summer species; records on the West Bench range from 16 July to 6 September.

Zoogeography

1. Faunal Elements

Grouping the twenty-one robber fly species into faunal elements based on their geographical distribution patterns produces a generalized picture of the assemblage's geographic origins. These faunal elements are derived from range patterns observed in this study, but follow similar treatments in Cannings and Cannings (1987) and Cannings *et al.* (1987). The species composition of the assemblage reflects a distinct western origin of the fauna (Fig. 4).

Cordilleran (28.5%). Species of mountain forests of western North America. Six of the 21 species inhabit open forests in the valleys and plateaus of the western mountains, typically from B.C. south to California. These species also occur in adjacent grasslands to some extent, some more abundantly than others. Included here are *Dioctria pusio*, *Eucyrtopogon nebulo*, *Eudioctria sackeni*, *Holopogon stellatus*, *Machimus occidentalis*, and *Neomochtherus willistoni*.

Intermontane (28.5%). Species of plateau and valley grasslands in the western mountains. Six species, *Comantella pacifica*, *Dicolonus nigricentrus*, *Efferia benedicti*, *E. coulei*, *E. harveyi*, and *Myelaphus lobicornis* are restricted to these grasslands. *C. pacifica*, *D. nigricentrus*, and *E. coulei* have rather restricted distributions in the northern grasslands of the Cordillera, from Washington north into the Chilcotin region of B.C. This Northern Intermontane element can be considered a subset of the Intermontane element, because it is distinct in its northern character. It is not treated separately in Fig. 4.

Western (28.5%). Species of the western mountains, associated lowlands and, to varying degrees, adjacent areas of the Great Plains. *Cophura brevicornis*, *Dicropaltum mesae*, *Efferia staminea*, *Lestomyia sabulona*, *Scleropogon neglectus*, and *Stenopogon inquinatus* are western species whose ranges extend east of the Rocky Mountains. Some reach only the western parts of the Great Plains, but others, such as *C. brevicornis* (Nebraska), *D. mesae* (Kansas), and *S. inquinatus* (Minnesota) range further east. Were it not for an extensive Great Plains component in their ranges, these species would be considered part of the Cordilleran or Intermontane elements. Only *C. brevicornis* and *S. inquinatus* are predominantly open forest species in the west.

Southern (9.5%). Species ranging transcontinentally south of the Boreal Forest, at least in the U.S.; in Canada only in extreme southern areas. *Proctacanthus milbertii* and *Efferia albibarbis*, in B.C. at least, are strictly grassland species. Both enter Canada only in southern B.C. and Ontario.

Boreal (5%). Species ranging transcontinentally in the Boreal Forest and southward in the western mountains to varying degrees. *Laphria sadales* is the sole Boreal species recorded; it ranges in the northern forests from B.C. east to Quebec. The presence of *L. sadales* in the study area is probably accidental; it is undoubtedly a visitor from nearby woodland. The Boreal faunal element cannot be expected to contribute to the origin of the western grassland fauna.

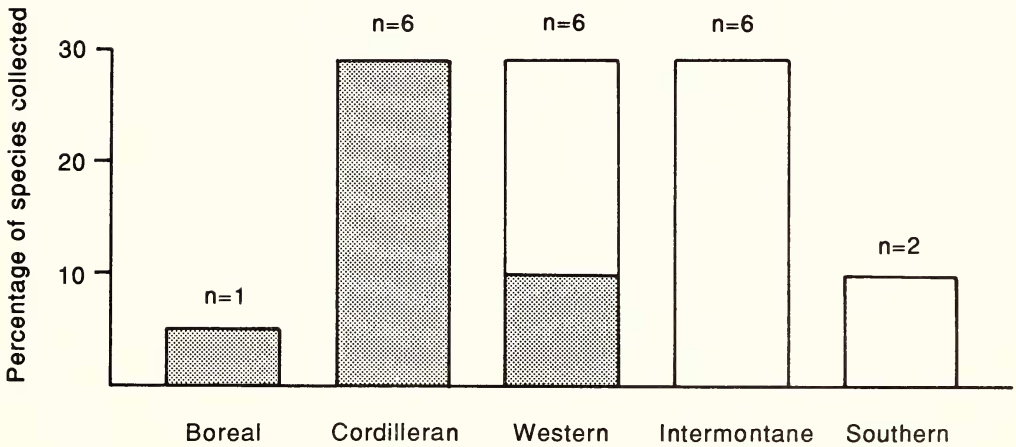


Figure 4. Origins of the fauna: percentage of species from different faunal elements, based on distribution patterns. The bars representing each element are further divided to show the general habitat preferences of the species included. (stippled = grassland and woodland; clear = grassland only)

2. Habitat

If *Laphria sadales* is eliminated from the list (its presence likely is accidental), 18 of the 20 remaining species are restricted to the grasslands and open, dry forests of western North America. The other two, *Proctacanthus milbertii* and *Efferia albibarbis*, are Southern elements and, in B.C. at least, are inhabitants of grasslands only. In the East and South, however, they may be found in regions where true grasslands do not exist, especially in open, sandy areas.

Forty-three per cent (9 species) of the assemblage lives in both open woodland and grassland (Fig. 4). Indeed, these species may be more common in the former habitat than in the latter; *Stenopogon inquinatus*, *Cophura brevicornis*, and *Eudioctria sackeni* are examples.

Microhabitat clearly plays an important role in the local distribution of many robber flies. Local differences in climate, soil type, and vegetation determine the presence of species in any small area of grassland. For example, the moister, darker soils associated with the cooler climatic regimes of grasslands above about 500 m in the southern B.C. Interior often are characterized by forbs such as *Balsamorhiza sagittata* (Pursh) Nutt. (Balsamroot) and *Lupinus sericeus* Pursh (Silky Lupine) and support several abundant species of asilids not found on the West Bench. *Cyrtopogon willistoni* Curran and *Stenopogon rufibarbis* Bromley are good examples. Several other species, common elsewhere, are absent from the study area. *Proctacanthus occidentalis* Hine is the dominant member of the genus in the grasslands of the Oliver-Osoyoos area; the soil there is usually coarse and sandy, and plants predominating include *Purshia tridentata* (Pursh) DC. (Antelope-brush) and *Aristida longiseta* Steud. (Red Three-awn Grass). *P. milbertii*, the West Bench species, occurs there as well, but in much lower numbers. The two species are more or less temporally separate, with *P. occidentalis* active in June and July and *P. milbertii* in August and September. No *Leptogaster* species have been recorded from the West Bench, although at least one species (near *L. fornicata* Martin) is present in the grasslands growing on the coarser, better drained soils further south. *Leptogaster* is a genus of small, elongate, rather fragile asilids (Asilidae: Leptogastrinae) that, in British Columbia, at least, perch on, and hunt from, grasses. *Efferia albibarbis* prefers sandy soils, and is common around Osoyoos Lake; the single specimen from the study area was not in its typical habitat. An undescribed species of *Efferia* common in the drier soils of Vaseux Lake to the south and Kalamalka Lake to the north is not present on the West Bench site. This species evidently is closely related to *E. coulei*, and like *E. coulei* is a spring species; its requirement for a different microhabitat is likely one of the barriers that separates them. *Efferia staminea* is rare in the study area; it is more common in the drier habitats dominated by *Agropyron* and *Stipa* grasses where the undescribed *Efferia* is found. *E. benedicti* is more common on the West Bench than its close relative *E. staminea*, but not as abundant as *E. coulei*. The preferred habitat of *E. benedicti* in the southern Okanagan is the dry, silty soil favoured by *Artemisia tridentata*. *E. harveyi* is common in both types of habitat.

Within the study area a few species show particular preferences for certain sites. *Myelaphus lobicornis* is restricted to the large clusters of *Chrysothamnus nauseosus* on the northeastern border of the area. It uses these shrubs as perching sites, but also lands on grass stems. Its particular relationship to the shrub is unclear, but the only other known locality for the species in B.C. and Canada is Dutch Creek near Columbia Lake where Rabbit-brush is also the dominant grassland shrub. *Eudioctria sackeni*, an example of a species mainly associated with shrubs and trees in open woodland (where it uses these larger plants for perching sites), was captured only in the two Malaise traps, both set adjacent to the shrub/grassland interface.

3. Phenology

Figure 3 illustrates that although June and July are the months with most species present, some flies have flight periods temporally separate from those of other species. Particularly striking is the observation that several closely related species, or species of similar size and habits (and thus perhaps potential competitors), fly at different times during the season. Thus,

Machimus occidentalis is active mainly in June and the related *Neomochtherus willistoni* flies mostly in August; their flight periods do not overlap. The two appear to fill very similar niches. Likewise, the three most common species of *Efferia* - *E. coulei*, *E. benedicti*, and *E. harveyi* - follow each other from spring to autumn, evidently doing similar things in the same place. All three species hunt from the ground, or from very low on grass stems. Presumably the separation of their flight periods allows the three species to live in the same habitat without much competition. Other behavioural differences may also be important. Lavigne and Dennis (1985) studied three sympatric *Efferia* species in Mexico and found that each foraged at different heights in the vegetation, predominantly at different times of day, and that the type of prey taken by each species exhibited very little overlap. They speculated that these factors allowed the three species to coexist. On the West Bench, prey selection was not observed often enough to be of use in this context. *Comantella pacifica* hunts in a similar manner to these *Efferia* species, and takes prey of a similar size to at least that of *E. coulei*. *Comantella's* flight period is very early and very late, bracketting all species of *Efferia*. The spring specimens appear fresh, suggesting to some students that *Comantella* species emerge in both the late fall and early spring. In Colorado, James (1937) felt that there was a partial emergence of *C. fallai* Back in the fall, with a continuation of the emergence the following spring. Dennis and Lavigne (1975), however, state that in Wyoming adults have been collected from beneath rocks in early March, indicating that they may overwinter in that stage. Whatever the mechanism, the very early and late flight periods enable *C. pacifica* to be active when no other robber flies can compete with them. *Lestomyia sabulona* and *Dicropaltum mesae*, although not closely related, are similar in size and hunting behaviour. The former is almost completely restricted to a May flight period; the latter, although first seen in May, is predominantly active in June and July.

As in many insects, there is a tendency in some species for males to emerge earlier in the season than females, although the data is too spotty to make significant analyses of this phenomenon. It is most noticeable in *Neomochtherus willistoni*, *Myelaphus lobicornis* and *Lestomyia sabulona*, and to a lesser degree in *Proctacanthus milbertii* and *Holopogon stellatus*. Females appear more common early in the flight period in *Dicropaltum mesae* and *Efferia benedicti*. Females seem to fly later in the season than males in some species; this is especially evident in the genus *Efferia*. Most species do not show major peaks in flight times, but *L. sabulona* evidently is most abundant at the end of the third week of May, *M. lobicornis* in the second week of June, *E. coulei* in the first two weeks of June, *Efferia harveyi* in the last week of August and the first week of September, and *Machimus occidentalis* in the first two weeks of June.

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BIOLOGY OF *Erythroneura elegantula* AND *E. ziczac* (HOMOPTERA: CICADELLIDAE) ON *Vitis vinifera* IN SOUTHCENTRAL WASHINGTON

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ABSTRACT

The western grape leafhopper, *Erythroneura elegantula* Osborn, and the Virginia creeper leafhopper, *Erythroneura ziczac* Walsh, were the only species of leafhoppers found colonizing grapevines, *Vitis vinifera* (L.), in southcentral Washington. Other Cicadellids collected did not colonize. Where the mymarid parasitoid, *Anagrus epos*, was found, the predominant leafhopper was *E. elegantula*. In the absence of *A. epos*, *E. ziczac* seemed to be the more abundant. *E. ziczac* quickly dominated a mixed population of both species in a greenhouse. On heavily damaged grape leaves, *E. ziczac* eggs remained surrounded by green tissue whereas *E. elegantula* eggs were not. This suggests the presence of a repellent or anti-feedant with *E. ziczac* eggs. Development time for *E. elegantula* averaged 402.6 D° which is much shorter than previously published times, and for *E. ziczac* averaged 390.5 D°.

Keywords: *Erythroneura elegantula*, *Erythroneura ziczac*, *Vitis vinifera*, wine grapes, leafhopper biology

INTRODUCTION

Doutt and Nakata (1973) believed that *Erythroneura elegantula*, the western grape leafhopper (WGLH) infested *Vitis californica* Bentham in California before the cultivation of *V. vinifera*. It was probably introduced into the Pacific Northwest on cultivated grapevines. Wolfe (1955) described WGLH as the leading insect pest of grape in Washington; it has the same distinction in California (Jensen and Flaherty, 1981).

Erythroneura ziczac, the Virginia creeper leafhopper (VCLH) was described by Walsh from a single specimen collected in Illinois (Beamer, 1936). It was recognized early as a minor pest of grape (Wirtner, 1904) and apple (DeLong, 1931), and as a principal insect pest of Virginia creeper and Boston ivy (Fairbairn, 1928; Pepper and Mills, 1936). VCLH occurs throughout the U.S. and southern Canada (Metcalf, 1968) but like WGLH is probably new to the Pacific Northwest, which has no native Vitaceae (Hitchcock and Cronquist, 1973). VCLH was recognized as the worst pest of *V. vinifera* grapes in British Columbia by McKenzie and Beirne in 1972.

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